CONTACT STRUCTURE FOR AN ELECTRICALLY OPERATED II/VI SEMICONDUCTOR ELEMENT AND PROCESS FOR THE PRODUCTION THEREOF

[0001] This application is a continuation application of United States Patent Application 10/111,661, filed April 24, 2002, which application is hereby incorporated by reference herein.

[0002] The invention concerns a contact structure for an electrically operated II/VI semiconductor element, as is known from the works by T. Honda, S. W. Lim, K. Yanashima, K. Inoue, K. Hara, H. Munekata, H. Kukimoto, F. Koyama and K. Iga, Jpn. J. Appl. Phys., 35, 3878 (1996) and S. W. Lim, T. Honda, F. Koyama, K. Iga, K. Inoue, K. Yanashima, H. Munekata and H. Kukimoto, appl. Phys. Lett. 65, 2437 (1994), and a process for the production thereof.

BACKGROUND OF THE ART

[0003] Semiconductor elements such as for example semiconductor laser diodes represent an essential basis of modern information and data processing systems and future display systems. While such laser diodes are available for the infrared, red and blue-violet spectral range, it has hitherto not been possible to produce a green semiconductor laser which enjoys an adequate service life. The most promising approach in terms of embodying a green semiconductor laser is based on II/VI semiconductor structures with ZnTe-bearing cover layers, but the service life of those components is still not satisfactory for commercial use (see E. Kato, H. Noguchi, M. Nagai, H. Okuyama, S. Kijima, and A. Ishibashi, Elec. Lett. 34, 282 (1998)).

[0004] Hitherto, those II/VI semiconductor laser structures with ZnTe-bearing cover layers were contacted by metals, typically palladium which is deposited on the semiconductor surface. Then platinum and/or gold are deposited on the palladium layer (see M. Haase, J. Qui, J. M. DePuydt, and H. Cheng; Appl. Phys. Lett. 59, 1272 (1991), M. Ozawa, F. Hiei, A. Ishibashi, and K. Akikmoto, Elect. Lett. 29.503 (1993) and S. Kijima, H. Okuyama, Y. Sanaka,

T. Kobaayshi, S. Tomiya, and A. Ishibashi; Appl. Phys. Lett. 73; 235 (1998)). The operation of applying those layers is carried out by means of vapor deposition, for example thermal vapor deposition or electron beam vapor deposition. The use of lithium nitride in II/VI semiconductor technology is hitherto only known as a doping material, in which case the material is diffused in at temperatures of between 350°C and 570°C (see T. Honda, S. W. Lim, K. Yanashima, K. Inoue, K. Hara, H. Munekata, H. Kukimoto, F. Koyama and K. Iga, Jpn. J. Appl. Phys., 35, 3878 (1996) and S. W. Lim, T. Honda, F. Koyama, K. Iga, K. Inoue, K. Yanashima, H. Munekata and H. Kukimoto, Appl. Phys. Lett. 65, 2437 (1994)). A laser use presupposes a doping concentration of at least 10^{18} cm^{-3}. That was only approximately attained at a temperature of 470°C, with that process. That temperature however would trigger off diffusion effects (for example of Cd) in the deeper laser layers, so that the consequence would be destruction of the laser structure. Therefore that process cannot be applied in laser technology.

[0005] The heat which is generated during electrical operation of the laser diode, for example due to the contact resistance at the contact, contributes substantially to the degradation of the entire structure.

SUMMARY OF THE INVENTION

[0006] A reduction in contact resistance is achieved by the present invention. A long service life for the contact structure is also ensured.

[0007] The process includes the application of lithium nitride (Li_3N) in a layer thickness of typically between 2 nm and 20 nm, to II/VI semiconductor structures, for example with ZnTe-bearing cover layers. That is effected for example by means of thermal vapor deposition, electron beam vapor deposition or vacuum sputtering. In combination with the covering of the lithium nitride layer, by means of cover layers, such as for example palladium and/or gold/platinum, oxidation of the lithium nitride in air is prevented. Typical layer thicknesses for those coverings are between 5 nm and 1 μm. In order to protect the side faces of the lithium nitride layer from oxidation, some embodiments provide that insulating materials (for example silicon nitride) can be applied.

The operation of tempering the structure results in a further reduction in the contact resistance. In addition that enhances the durability of the contact. A further possible way of improving the contact properties (for example adhesion of the lithium nitride to the sample surface) is afforded by the use of thin bonding layers (for example metalization layers) between the semiconductor and the lithium nitride.

[0008] The contact resistance of II/VI semiconductor structures (for example laser diodes) and thus the thermal stressing thereof can be greatly reduced by the use of that lithium nitride layer. That results in a slower rate of degradation of those components and thus affords longer service lives.

[0009] Commercial availability of green semiconductor laser diodes opens up a large number of possible uses such as laser television or an improvement in laser printing.

BRIEF DESCRIPTION OF THE DRAWING

[0010] An embodiment of a contact structure according to the invention is shown in Figure 1.

Abbreviations:

ZnTe:	zinc telluride
Li_3N:	lithium nitride
Cd:	cadmium

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

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